THREE-TIER DETECTION AND MULTI-LEVEL SYNERGY FOR COASTAL MIXED-LAND ZONE CLASSIFICATION

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my beloved parents Mohd Pouzi bin Hamzah and Murni binti Ghani
my precious siblings Muhamad Afiq and Adlina Najihah
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ABSTRACT

Vegetation, urban terrain and water are considered as the problematic segments in land use and land cover classifications because of confusion factors. These segments are vulnerable to high misclassification level. In addressing these problems, several fundamental issues shall be emphasized: ineffective stand-alone data classification, high investment for data fusions and the need for high frequency of data collection. Thus, this research proposes a classification method consisting of two important components: Three-tier Detection (TTD) and Multi-level Synergy (MLS) after evaluating LiDAR point cloud, aerial photography, Quickbird and Landsat 7 ETM+ images. TTD which is a hierarchical and priority-based data fusion method is used to solve the vegetation and urban terrain classification while MLS, which is a synergy strategy by the utilization of single data and robust learning algorithms is used for water classification. The creation of TTD that has managed to outperform the stand-alone data classification made it a worthwhile investment while for MLS, the usage of single data is capable of meeting the high data collection demand. Both methods started with data processing such as image filtering followed by the comparison of several existing techniques for each data (rank) to identify their potentials and limitations. Next, multi-level data fusions and multi-level synergy are conducted for TTD and MLS, respectively. The dataset employed is Bukit Kanada, Sarawak which exemplifies a coastal mixed-land zone. The performance is then measured using statistical indices include overall accuracy and Kappa Index of Agreement. Both TTD and MLS outperformed recent works such as Normalized Digital Surface Model, Edge Detection technique and Support Vector Machine. Based on the success rates, TTD is suitable to be applied in planning and development sectors, management and detection of land use changes while MLS is suitable for creating maps, charts, and also in monitoring national coastline.

ABSTRAK

Cabaran utama dalam pengklasifikasian penggunaan dan penutupan tanah adalah kekeliruan yang berlaku pada segmen-segmen yang bermasalah seperti tumbuh-tumbuhan, kawasan bandar dan air. Segmen-segmen ini terdedah kepada tahap keterlepasan pengklasifikasian yang tinggi. Bagi menangani permasalahan ini, beberapa isu asas perlu dititikberatkan iaitu pengklasifikasian data tunggal yang tidak berkesan manakala paduan data melibatkan pelaburan yang tinggi serta kebergantungan kepada frekuensi pengumpulan data yang tinggi. Oleh yang demikian, kajian ini telah memperkenalkan satu kaedah pengklasifikasian yang terdiri daripada dua komponen penting iaitu *Three-tier Detection* (TTD) dan *Multi-level Synergy* (MLS) setelah menilai beberapa data. TTD merupakan kaedah paduan data yang berasaskan kepada hierarki dan keutamaan yang digunakan untuk pengklasifikasian tumbuh-tumbuhan dan kawasan bandar manakala MLS yang merupakan strategi sinergi berdasarkan kepada data tunggal dan algoritma-algoritma pembelajaran digunakan untuk pengklasifikasian air. Pencapaian TTD yang telah berjaya mengatasi pengklasifikasian data tunggal menjadikannya suatu pelaburan yang berbaloi manakala MLS yang dioperasikan berdasarkan data tunggal dilihat mampu memenuhi kebergantungan kepada frekuensi pengumpulan data yang tinggi. Kedua-dua kaedah ini bermula dengan pemprosesan data seperti penapisan imej dan diikuti dengan perbandingan beberapa teknik yang sedia ada untuk setiap data bagi mengenal pasti potensi dan kelemahannya. Seterusnya, pelbagai peringkat paduan data dan sinergi diuji bagi TTD dan MLS. Lokasi kajian ini ialah Bukit Kanada, Sarawak yang merupakan zon tanah bercampur di kawasan pantai. Berdasarkan indeks-indeks statistik termasuk ketepatan keseluruhan dan *Kappa Index of Agreement*, TTD dan MLS telah berjaya mengatasi kerja-kerja baru seperti *Normalized Digital Surface Model*, teknik *Edge Detection* dan *Support Vector Machine*. Dengan pencapaian ini, TTD sesuai untuk diaplikasikan dalam sektor perancangan dan pembangunan, pengurusan dan pengesanan perubahan penggunaan tanah manakala MLS sesuai untuk mewujudkan peta, carta dan juga memantau perairan kebangsaan.